U.S. DEPARTMENT OF COMMERCE
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PB-255 573

FORT COLLINS WASTEWATER TREATMENT FACILITY, FORT COLLINS, COLORADO

ENVIRONMENTAL PROTECTION AGENCY

MAY 1973

S-2

212028

PB 255 573

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BIBLIOGRAPHIC DATA SHEET	1. Report No. SA/TSB-22	2.	3. Recipient's Accession No. PB-255 573
4. Title and Subtitle Fort Collins Wastewater Treatment Facility, Fort Collins, Colorado.			5. Report Date May 73 6.
7. Author(s)			8. Performing Organization Rept. No.
9. Performing Organization Name and Address Environmental Protection Agency, Denver, Colo. Technical Support Branch.			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address			13. Type of Report & Period Covered 14.

15. Supplementary Notes

16. Abstracts

On October 25, 1972, personnel from the Environmental Protection Agency, Region VIII, and from the Colorado State Department of Health conducted an operation and maintenance survey of the Fort Collins Wastewater Treatment Plant No. 2 (activated sludge plant). The data collected during this study showed that the Fort Collins plant generally was producing a good quality effluent. The purpose of the report is to document the results from the technical assistance project.

17. Key Words and Document Analysis. 17a. Descriptors

*Sewage treatment,
*Activated sludge process,
*Cache La Poudre River,
Site surveys,
Waste water,
Performance evaluation,
Design,
Technical assistance,
Dissolved gases,
Oxygen,
Turbidity,
Maintenance,
Aeration,
Colorado.

17b. Identifiers/Open-Ended Terms

*Sewage treatment plants,
Fort Collins (Colorado),
Dissolved oxygen.

17c. COSATI Field/Group 13 B,

18. Availability Statement National Technical Information Service Springfield, Va. 22161	19. Security Class (This Report) UNCLASSIFIED	21. No. of Pages 30
	20. Security Class (This Page UNCLASSIFIED	22. Price $4.00/$2.25

FORM NTIS-35 (REV. 10-73) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 8265-P74

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S&A/TSB - 22

TECHNICAL ASSISTANCE PROJECT

FORT COLLINS WASTEWATER TREATMENT FACILITY

FORT COLLINS, COLORADO

JANUARY - FEBRUARY, 1973

TECHNICAL SUPPORT BRANCH

SURVEILLANCE AND ANALYSIS DIVISION

U. S. ENVIRONMENTAL PROTECTION AGENCY

REGION VIII

MAY, 1973

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I. Introduction

On October 25, 1972, personnel from the Environmental Protection Agency, Region VIII, and from the Colorado State Department of Health conducted an operation and maintenance survey of the Fort Collins Wastewater Treatment Plant #2 (activated sludge plant). The data collected during this study showed that the Fort Collins plant generally was producing a good quality effluent. However, the data also indicated that cycles of good quality effluent and poorer quality effluent were occurring. In an effort to produce a consistently high quality effluent, a technical assistance project was initiated at the Fort Collins facility on January 15, 1973.

The purpose of this report is to document the results from the technical assistance project. The operational controls initiated during the project as well as design limitations observed are outlined in the report. The results achieved in producing a consistently high quality effluent are also discussed.

It is noted that Fort Collins also operates and maintains a trickling filter wastewater treatment facility. No assistance was provided concerning this plant.

II. Description of Plant

The Fort Collins Plant #2 is an activated sludge facility which treats primarily domestic sewage from the south portion of the City. The daily average flow in 1972 was about 20,817 cu. m/day (5.5 MGD) during the summer (high flow due to infiltration) and 15,112 cu. m/day (3.9 MGD) during the winter.

Figure 1 depicts a schematic diagram of the various plant units. Flow enters the plant by gravity and is pumped to the primary clarifiers. Raw sewage may also be pumped, if required, directly to the distribution channel between the two aeration basins. Effluent from the primary clarifiers enters the distribution channel between the two aeration basins and is directed to the basins by opening or closing the appropriate sluice gates. Sluice gates

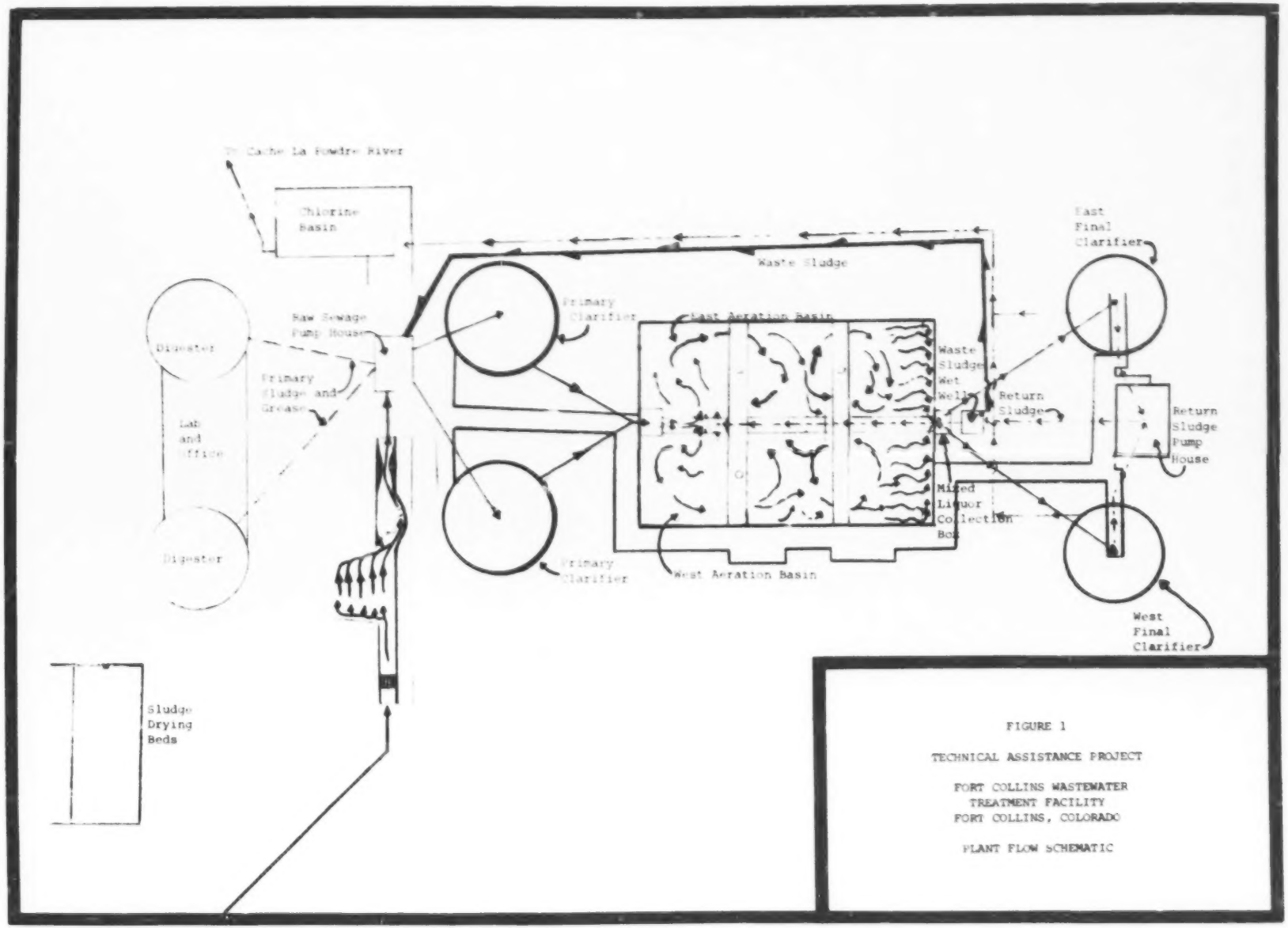

FIGURE 1

TECHNICAL ASSISTANCE PROJECT

FORT COLLINS WASTEWATER
TREATMENT FACILITY
FORT COLLINS, COLORADO

PLANT FLOW SCHEMATIC

are located at the head end and half way down each aeration basin. Flow from the primary clarifiers can by-pass the aeration basins directly to the secondary clarifiers or to the chlorine contact basin. This by-passing may be accomplished by opening or closing a sluice gate located at the end of the aeration basin distribution channel.

Mixed liquor from each aeration basin is directed to a collection box located at the end of the two basins. Flow from the collection box is distributed to the final clarifiers through mud valves.

Sludge is collected in the secondary clarifiers by suction type scraper mechanisms and is returned through a common header to the aeration basins by three variable speed centrifugal pumps. These pumps may be used and adjusted independently. Return sludge may be added to the aeration basins through ports at the head end of the basins or through ports located halfway down the basins. Return sludge flow is measured by an inline venturi meter.

Excess activated sludge is wasted to the raw sewage wet well and then pumped to the primary clarifiers. Prior to assistance, excess activated sludge was wasted by lowering a telescoping valve located on the return sludge line. During assistance this valve was plugged and sludge was wasted by opening a two-inch gate valve located on a two-inch pipe which was welded into the telescoping valve. The waste sludge flow rate varied with changes in the return sludge flow. Therefore, it was necessary to determine the wasting rate at various return sludge flow rates.

Effluent from the secondary clarifier is directed to a chlorination basin and is discharged to the Cache-La Poudre River.

Sludge and grease from the primary clarifiers are pumped to anaerobic digesters which are being operated in series (i.e., primary, secondary digesters).

III. Summary of Assistance Project

It was felt initially that the project at Fort Collins would be directed at initiating control testing procedures to enable the operators to "fine tune" the facility and eliminate the fluctuations in effluent quality. It was determined, however, that some modifications were required to the existing facilities to achieve desired operational results and flexibility. Some of the desired modifications could not be made during the assistance project and these changes will be discussed in the recommendations.

A. Control Testing

A series of control tests were initiated at the Fort Collins facility to enable the operators to closely monitor the processes and to indicate when process controls needed to be changed (i.e., adjustment of return sludge flow rates, adjustment of the quantity of activated sludge to be wasted, adjustment of dissolved oxygen concentrations, etc.). Several of the control tests initiated were used by plant personnel before the assistance project. These tests were modified slightly and incorporated into a routine testing procedure.

The control tests initiated were dissolved oxygen determinations, centrifuge tests, turbidity, settleability tests, and sludge blanket depth determinations. These tests were conducted four times per day, seven days per week.

Dissolved oxygen (D.O.) tests were used to monitor the availability of D.O. in the aeration basins. The most critical points for the availability of D.O. were determined by taking measurements throughout the length of the basins.

Centrifuge tests were used to determine variations in solids concentrations throughout the day and from day to day. Tests were conducted on samples of mixed liquor taken at the discharge end of each aeration basin and on samples

of return sludge. The centrifuge test values are expressed in percent solids by volume. Although it is not necessary for control, a correlation between percent solids by volume and solids by weight was made. The results of this correlation indicated that during the project one percent solids by volume was approximately equal to 670 mg/l by weight. This correlation will vary as the characteristics of the sludge varies. For this report all solids concentrations by weight were determined by using the correlation of one percent by volume equal to 670 mg/l by weight.

Turbidity tests were performed on samples of the effluent from one of the final clarifiers. Test results were used to minotor the performance of the activated sludge process prior to obtaining a BOD_5 result.

Settleability tests were conducted on samples of the mixed liquor collected at the discharge end of the aeration basins. Settleability tests were used to monitor and observe sludge settling characteristics.

Sludge blanket depth determinations were made on the final clarifiers. Results were used to monitor changes in the depth of the blanket and to determine the amount of sludge that was accumulating in the final clarifier. It is noted that the blanket depth determinations and wasting control procedures were begun after the initial EPA inspection in October, 1972. The effect of using this portion of the control testing procedures will be shown when effluent quality is analyzed.

Data obtained from the various control tests were used to perform calculations and develop various graphs. The results of the calculations and the trends from the graphs were used to interpret plant performance and control plant operations.

B. Process Modifications

During the assistance project, various problems were encountered that inhibited plant operation and flexibility. In most cases, these problems were corrected by plant personnel. In fact, plant personnel are to be commended

for their efforts in utilizing available material to satisfactorily complete the required physical modifications within a short period of time. Other modifications that could improve plant performance could not be completed during the assistance project. These modifications will be presented and discussed in the report for future considerations at the Fort Collins plant.

1. Physical Modifications

The first change made at the Fort Collins Plant #2 involved the method of returning activated sludge and wasting excess activated sludge. Prior to assistance the return sludge flow was divided as equally as possible between the four return sludge ports located in the aeration basins (See Figure 1). To eliminate any possibility of sludge "short circuiting" through the aeration basins it was decided to return the activated sludge through the two ports located at the head end of each aeration basin. When this was attempted, the increased pressure required to force the return sludge to the head end of the aeration basins was sufficient to force solids out of the telescoping valve used for wasting excess activated sludge and thus solids were wasted unintentionally. Therefore, the telescoping valve was plugged, and an alternative method of wasting was accomplished by welding a valved two inch pipe into the telescoping valve. This method of wasting allowed for smaller amounts of excess activated sludge to be removed from the system over longer periods of time.

Operational problems were encountered in trying to adjust return sludge flow rates to achieve optimum solids removal with a minimum amount of water contained in the return sludge. The control tests indicated that discrepancies existed in the laboratory data and the performance of the facility. An investigation led to the discovery of leaking seals located around the return sludge center well of each of the suction type secondary clarifiers. The effect of the leaky seals was to allow mixed liquor to dilute the return sludge flow. In fact, a solids balance conducted around the final clarifier indicated that approximately 40 percent of the return sludge flow was comprised

of mixed liquor. Excessively high return rates were required to compensate for the dilute return sludge and to maintain a desired solids concentration in the aeration basins. It is also felt that a portion of the cycling problem that Fort Collins experienced with effluent quality can be attributed to the leaking seals. The leak inhibited proper adjustment of return sludge flow rates and thus allowed the plant to operate somewhat at its own will.

In an effort to conserve time, the seals on both clarifiers were replaced in a one-day period. Although this virtually eliminated the leaking problem, it also served to remove all the solids contained in both final clarifiers from the system. (They were wasted to the primary clarifiers.) This solids loss had a terrific impact on the assistance project as was determined through operational difficulties encountered after the seals were fixed. This aspect of the assistance project will be discussed later in the report. It is recommended that the seals be routinely checked at least once a year and replaced when necessary. It is also recommended that the replacement process be designed to eliminate excessive losses of sludge from the activated sludge system.

Prior to assistance, personnel at the Fort Collins wastewater treatment plant were operating the mud valves used to direct the flow to the final clarifiers so that the flow or mixed liquor would "back up" in the aeration basins. This operation served a dual purpose of equalizing a small amount of the incoming sewage flow and also increased the liquid depth in the aeration tanks allowing the fixed surface mechanical aerators to supply additional oxygen to the mixed liquor. Two problems were encountered with this kind of operation.

The first problem was one of providing a consistently adequate supply of dissolved oxygen. After several other methods had been tried, a solution to controlling the dissolved oxygen concentration was achieved by raising the adjustable weir on the effluent from the aeration basins. These

weirs had not been adjusted for several years and had rusted tight in the lowered positions. Raising the weirs allowed the water level in the basins to increase and thus enabled the fixed mechanical aerators to supply additional oxygen. The advantage of this arrangement was that water did not have to be "backed up" in the aeration tanks daily to ensure an adequate supply of oxygen. During the process of raising the effluent weirs on the aeration basins it was noticed that the rubber seals along the bottom of the weirs was leaking. In fact, the leak in the west aeration basin was so severe that a hydraulic imbalance was created between the aeration basins and it became difficult to achieve equal mixed liquor concentrations between the two basins. To compensate for this leak, a portion of the effluent weir on the west basin was blocked off and more equal mixed liquor concentrations were obtained. It is recommended that the more permanent solution to the problem would be replacing the rubber seals along the adjustable weir. It is also recommended that these seals be routinely checked at least once a year and that care be taken when replacing the seals to avoid excessive losses of sludge from the activated sludge system.

The second problem encountered by daily adjusting the mud valves to the final clarifiers was one of flow distribution. Many times the quantity of sludge in one clarifier would greatly exceed the quantity in the other. Since mud valves are not good valves for flow control, it was felt that if both valves could be left wide open that equal flow and thus sludge distribution would result. This proved not to be the case; however, since the collection box where the mixed liquor is directed to the final clarifiers was not symmetrical. The turbulence and non-symmetrical arrangement of this collection box caused flow variations between the final clarifiers to occur. A wooden baffle was placed in the collection box to eliminate a portion of the turbulence. This resulted in a more uniform flow distribution to the final clarifiers.

The final clarifiers at Fort Collins are equipped with a suction-type scraper mechanism. An operational problem was encountered in trying to "draw" a uniformly thick concentration from each of the eight removal ports. Adjustments were made to try to balance the return sludge concentration from each port. It is recommended that these ports be monitored routinely to insure a uniform sludge concentration in the return sludge flow.

2. Operational Modifications

Initially, it was felt that the lack of fine tuning was causing the cycling effect in the effluent quality at the Fort Collins #2 plant. However, it was determined that this was not the problem. The major operational problem at the Fort Collins plant is one of developing and maintaining a mature good settling sludge. After discussing past difficulties encountered by present and previous operators, it became apparent that this problem has plagued the plant since it began operation.

Developing and maintaining a mature good settling sludge at Fort Collins requires that a sufficient mass of sludge be held in the system to insure favorable food to micro-organism ratios consistent with the physical facilities provided. When both seals in the final clarifiers were replaced, a large portion of the solids that the operators had accumulated in the system were removed. The result of this loss of solids was that a poor settling sludge developed in the system. The first attempt at improving sludge settleability was to simply stop wasting and let the sludge mass increase to a desired level. This proved to be difficult since solids would readily "bulk" from the final clarifiers and not allow a substantial increase in sludge mass in the system. This has been a continual problem at the Fort Collins plant in the past. The relationship of the size of the clarifiers and aerators at the facility is such that increasing solids to a desired level is hindered because bulking in the final clarifiers limits an increase in sludge

mass by "automatically" wasting solids from the system. First glance at this problem indicates that additional clarifiers are needed to eliminate the bulking. Although this may provide a solution, it is not felt that this is the most desirable approach.

Aeration basin detention time is a limiting factor in allowing the development of a good settling sludge at the Fort Collins facility. Normal aeration basin detention times are from 6 to 8 hours for conventional activated sludge systems. Based on daily average flows aeration basin detention times at Fort Collins range from a high of 5.7 hours during winter months (Flow = 14,383 cu. m/day (3.8 MGD))to a low of 3.9 hours during summer months when infiltration occurs (Flow = 20,817 cu. m/day (5.5 MGD)). Although the Fort Collins plant is designed to operate as a conventional type of facility the aeration basin detention times are minimal. This problem is accentuated when a poor settling sludge exists in the system. Poor settling sludges require high return sludge flow rates to maintain a desirable solids concentration in aeration basins. The effect of the high return rates is that it cycles the sludge quickly through the aeration basin. For example, the effective sewage detention time is equivalent to the volume of the aeration basins divided by the incoming flow while the effective sludge detention time in the aerator is equivalent to the volume of the aeration basins divided by incoming flow plus the return sludge flow. This factor becomes increasingly significant when trying to develop a mature good settling sludge.

To develop a good settling sludge requires that the sludge be in the environment of the aerator in sufficient quantity so that desirable food to micro-organisms ratios are achieved. Therefore, it was decided to try to operate the Fort Collins facility in the contact stabilization mode. All of the return sludge flow was returned to the head end of the aeration basins while the incoming sewage was introduced at the inlet gates located half way down the aeration basins. Supposedly, the head end of the aeration

basins should have contained sludge at a concentration approximately that of the return sludge flow and thereby should have increased the mass of sludge in the aeration basins. However, due to the effective mixing provided by the surface mechanical aerators, no differentation of solids concentration could be detected in the aeration basins. The method of using contact stabilization to provide adequate sludge detention time in the aeration basins would be desirable especially during the summer months when high infiltration occurs and aeration basin detention times are at a minimum. A suggested arrangement would be to use one aeration basin as a reaeration tank and one as a contact tank. A few minor modifications would give the operators the contact stabilization flexibility.

Along these same lines an approach to increase the mass of sludge at the Fort Collins plant was devised. Since it was difficult to increase solids without severe bulking, it was decided to use one of the aeration basins to store solids until a desired mass was accumulated. This was accomplished by loading only one aeration basin with incoming sewage and putting only a portion of the return sludge flow in the other basin. This allowed an accumulation of solids at a higher concentration in the aeration basin not receiving any sewage flow. When the desired mass of solids had been accumulated in the system, the plant was switched back to the conventional mode of operation (i.e., all sewage and return sludge introduced at the head end of the aeration basins). High mixed liquor concentrations (approximately equal to 3000 mg/l) were achieved in both aeration basins. The poor settling solids were kept in the system by minimizing bulking. The procedure used to minimize bulking was to by-pass primary effluent directly to the final clarifiers and thus decrease the solids loading on the secondary clarifiers. This method of operation was carried on about a week to give the sludge a chance to develop better settling characteristics. As the sludge began settling better, less and less primary effluent had to be by-passed to the secondaries and finally all the flow was handled through the aeration basins.

In summary, the aeration basins and final clarifiers at Fort Collins are sized so that difficulties are encountered in trying to develop and maintain a good settling sludge. The major factor influencing these difficulties is the minimal size of the aeration basins. When low solids concentrations occur, such as during start-up or as a result of breakdowns or maintenance, it is recommended that the procedure used during assistance (i.e., building solids in one aeration basin and storing them in the other) be used to aid in rapid development of a good settling sludge.

Another major operational problem at the Fort Collins plant is the limited time during the day the plant is operated. Due to the relatively small aeration basins it becomes necessary to continually readjust return sludge flow rates as the flow changes. For example, in extended aeration activated sludge plants (aeration basin detention time = 24 hours) the incoming flow has little impact on the contents of the large aeration tank and as a result, return adjustments, although necessary, are not as critical. The smaller the aeration basin becomes (i.e., shorter detention times) the more sensitive the mixed liquor concentration is to the incoming flow. Since the Fort Collins plant has only eight hours a day operation all adjustments to return rates must be accomplished in an eight-hour period. This proved to be unsatisfactory during the assistance project and plant personnel were requested to come in "after hours" to make adjustments in return sludge flow rates. However, the flow does not significantly change until 2:00 a.m. in the morning, and this was too late to expect the operators to stay on the job. The result of not adjusting return sludge flow rates especially in a plant with short aeration basin detention times is that a lower inventory of solids must be carried to avoid bulking problems. The lower solids inventory and the lack of return adjustments to maintain the highest mixed liquor concentration possible, results in a poorer quality effluent than could be achieved if return adjustments were made. It is recommended that twenty-four-hour

operation be provided at the Fort Collins facility so that optimum performance can be achieved.

3. Future Modifications

Although numerous operational and physical modifications were made at the Fort Collins plant several areas that pose operational problems still exist. Perhaps the most significant area of difficulty encountered at the Fort Collins plant was the relationship between the volume of the aerators and the clarifiers. The effect of this imbalance in volumes can be pointed out by first comparing two variations of the activated sludge process (i.e., high rate processes versus conventional processes). High rate activated sludge processes are characterized by relatively small aeration basins and large final clarifiers. Settling characteristics associated with the process are generally considered to be relatively poor. Conventional activated sludge processes generally exhibit better settling characteristics and are characterized by larger aeration basins and smaller clarifiers in relation to a high rate process. At Fort Collins the relatively short detention times in the aeration basins result in the process tending toward the high rate activated sludge variation. As a result, the clarifiers appear to be unsatisfactory any time the system gets out of balance. Although an additional clarifier may provide satisfactory performance, a better approach would be to provide additional aeration capacity. This would enable the process to tend more toward the conventional activated sludge process and its associated better settling characteristics. The result would be to provide a more easily controllable plant capable of producing a higher effluent quality.

Another modification that would aid the operators in controlling the present facility would be to provide them with the flexibility to operate one aeration basin as a reaeration tank and the other as a contact tank. This modification would allow plant personnel to maintain a high inventory of sludge during the summer months when infiltration rates increase

significantly. During the summer months in the past, difficulties have been encountered in maintaining an adequate amount of sludge due to solids losses in the effluent from the final clarifiers.

Another area of operational difficulty was encountered in trying to adjust and maintain low return sludge flow rates. Low rates were accomplished by partially closing the plug valves provided on the discharge side of the centrifugal return sludge pumps. This proved unsatisfactory because during the night the valves would become plugged with debris and significantly reduce the desired return flow rates. This problem could be reduced if twenty-four hour operation were provided. Also, at low return sludge rates precise flow measurement was difficult. It is suggested that additional flow meters that provide more precise flow readings at low flows (i.e., less than 63.1 l/sec (1000 gpm)) be installed. Consideration should also be given to providing a smaller return sludge pump so that valving with the associated plugging problems could be minimized.

Waste sludge flow control and measurement at the Fort Collins plant lacks the flexibility that the operator needs to maintain close control over his process. Waste sludge flow rates are difficult to determine and change constantly as the return sludge flow rate is adjusted. A more desirable and controllable approach would be to provide a wasting system that is separate from the return sludge system and one where wasting rates could be adjusted to a desired level and measured.

Two other modifications that would assist plant personnel in providing a consistently high quality effluent would be to provide the flexibility to use one or both of the primary clarifiers as flow equalization basins and to provide the capability to add polymers or chemicals to the aeration basin effluent to aid settling in the final clarifiers.

Flow equalization could be accomplished by providing a method for the primary clarifiers to drain to the influent wet well during the night. The result of this modification would be to lessen the impact of peak daily flows on the mixed liquor solids concentration in the present aeration basins. Also, the solids loading rate on the final clarifiers would be lessened by decreasing the magnitude of peak flows.

The ability to add polymers and chemicals to the mixed liquor to aid settling would allow the operators to minimize solids losses in the effluent during period of imbalance (i.e., breakdowns, shutdowns for maintenance, periods when poor settling sludge exists, etc.)

C. Performance Results

The primary objective of the technical assistance project at Fort Collins was to produce a consistently high quality effluent. To demonstrate the "cycling" effect on plant effluent quality, plant data was analyzed for 4-1/2 months prior to the initiation of the assistance project. A period of 4-1/2 months after initiation of the assistance project was also analyzed to show the results of assistance. Data analyzed included the biochemical oxygen demand (BOD_5) of the plant influent, final clarifier effluent, and chlorine contact tank effluent (i.e., plant effluent) and the total suspended solids (TSS) of the chlorine contact tank effluent. The samples for these analyses were collected three times each day and were composited. No attempt was made to composite samples proportional to flow. The laboratory analyses were performed the following day.

During the assistance project, plant operators spent a considerable amount of time repairing plant deficiencies noted during assistance and learning and using the techniques initiated to control plant operation. Due to this increased demand on their time, the TSS results are incomplete during the course of the assistance project.

Figure 2 shows the 7-day moving average BOD_5 concentration of the final clarifier effluent and chlorine contact tank effluent. Figure 3 shows the 7-day moving average TSS concentration of the chlorine contact tank effluent. Data is shown for the period of September, 1972, through May, 1973. These figures show the cycling of effluent quality that occurred prior to the assistance project (before January 15, 1973). The BOD_5 concentration of the final clarifier effluent varied from about 55 mg/l to about 13 mg/l and the BOD_5 concentration of the chlorine contact tank effluent (plant effluent) varied from about 45 mg/l to about 10 mg/l. The plant effluent TSS concentration varied from about 63 mg/l to about 15 mg/l. The fluctuations in effluent quality are in part a result of many of the deficiencies that existed in the facility prior to technical assistance (i.e., leaky seals, inadequate flow splitting, small aerators, return sludge flow control, etc.)

It should be noted that a portion of the operational controls used during the formal assistance project were initiated approximately one month prior to beginning the project. (Shown on Figures 2 and 3). After initiation of these controls plant effluent BOD_5 concentrations were achieved below 20 mg/l and are comparable to BOD_5 concentration values achieved after completion of the assistance project. Plant effluent TSS, however, was between 20 and 30 mg/l during this one month period, much higher than TSS values achieved after completion of the assistance project. Apparently, changes in plant operation as a result of the assistance project provided conditions for better solids capture and lower TSS values.

During assistance plant effluent quality was not satisfactory due to operational problems encountered as a result of the many changes. After these operational problems were solved, however, plant effluent BOD_5 and TSS values were never greater than 20 mg/l (i.e., the 1975 Colorado Effluent Standard). The final clarifier effluent BOD_5 value did exceed 20 mg/l for a short period of time during the first of May. These higher BOD_5 values can be attributed

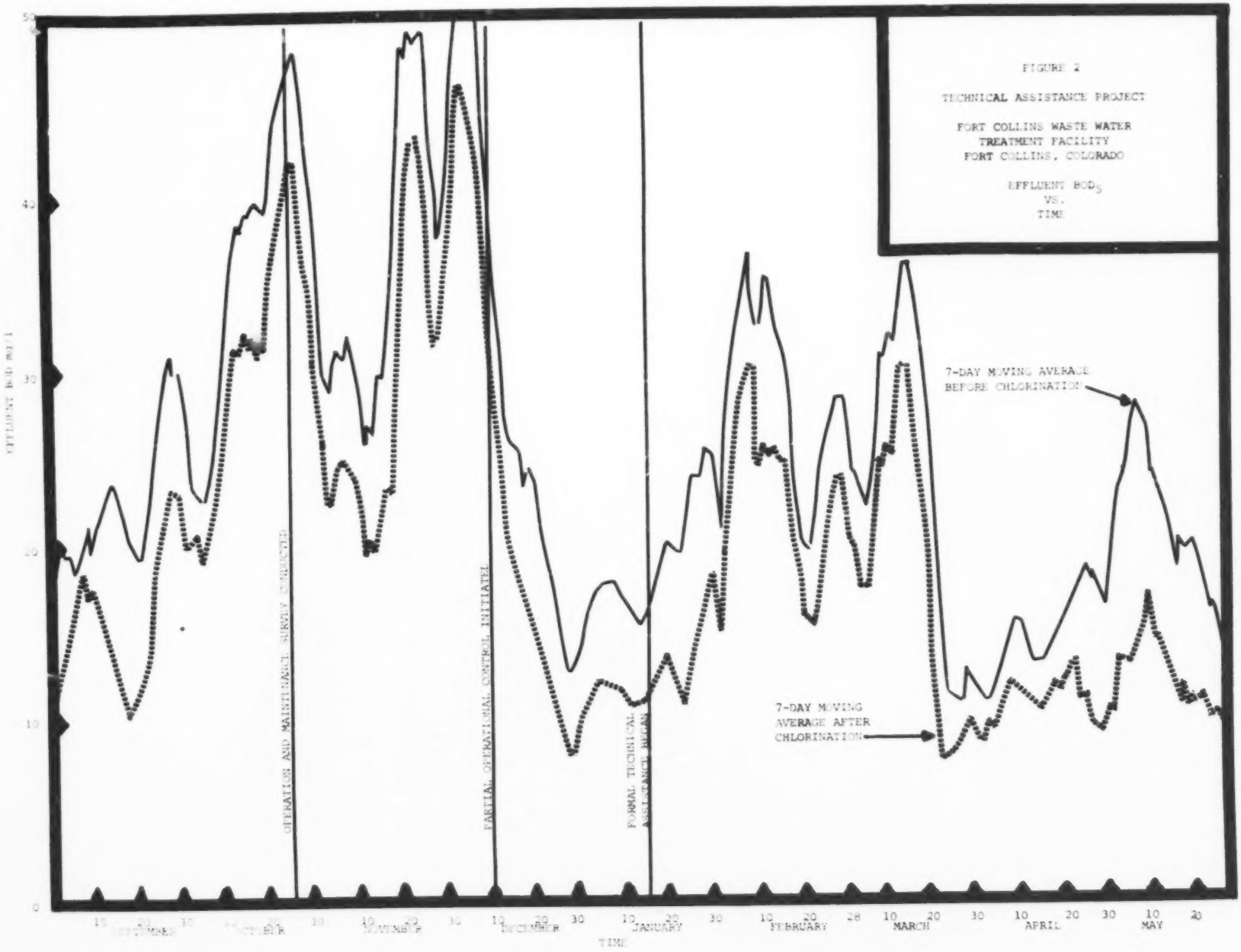
FIGURE 2
TECHNICAL ASSISTANCE PROJECT
FORT COLLINS WASTE WATER TREATMENT FACILITY
FORT COLLINS, COLORADO
EFFLUENT BOD_5 VS. TIME
7-DAY MOVING AVERAGE BEFORE CHLORINATION
7-DAY MOVING AVERAGE AFTER CHLORINATION
OPERATION AND MAINTENANCE SURVEY CONDUCTED
PARTIAL OPERATIONAL CONTROL INITIATED
FORMAL TECHNICAL ASSISTANCE BEGAN
EFFLUENT BOD mg/l
0
10
20
30
40
50
10 20 30 OCTOBER 10 20 30 NOVEMBER 10 20 30 DECEMBER 10 20 30 JANUARY 10 20 30 FEBRUARY 10 20 28 MARCH 10 20 30 APRIL 10 20 30 MAY
TIME

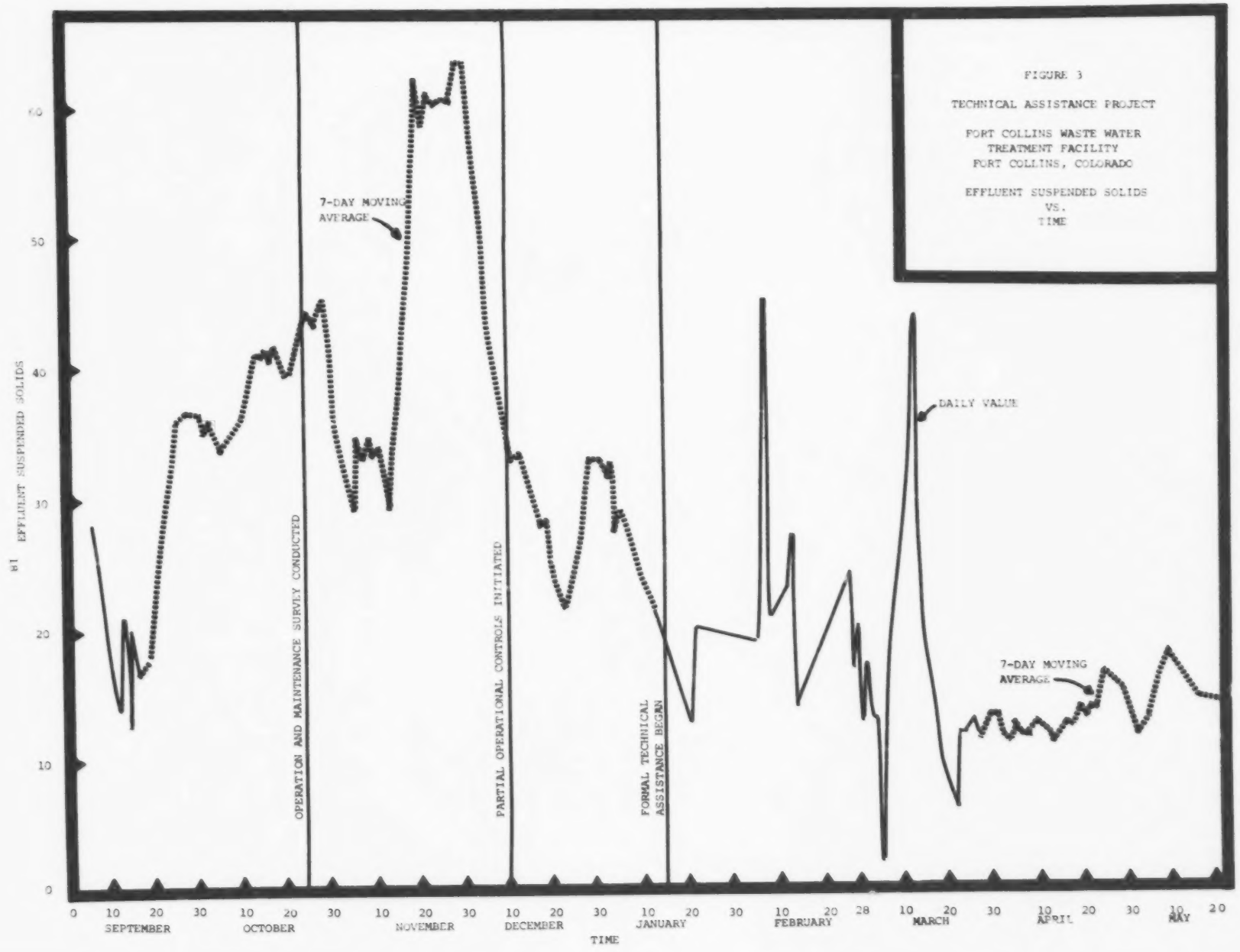
FIGURE 3
TECHNICAL ASSISTANCE PROJECT
FORT COLLINS WASTE WATER TREATMENT FACILITY
FORT COLLINS, COLORADO
EFFLUENT SUSPENDED SOLIDS VS. TIME
EFFLUENT SUSPENDED SOLIDS
mg/l
0
10
20
30
40
50
60
7-DAY MOVING AVERAGE
DAILY VALUE
7-DAY MOVING AVERAGE
OPERATION AND MAINTENANCE SURVEY CONDUCTED
PARTIAL OPERATIONAL CONTROLS INITIATED
FORMAL TECHNICAL ASSISTANCE BEGAN
0 10 20 30 10 20 30 10 20 30 10 20 30 10 20 30 10 20 28 10 20 30 10 20 30 10 20
SEPTEMBER
OCTOBER
NOVEMBER
DECEMBER
JANUARY
FEBRUARY
MARCH
APRIL
MAY
TIME

to higher plant flows (due to infiltration) and the associated problems with the relatively short aeration basin detention times and inadequate return sludge flow control (due to limited plant staffing). These problems were partially overcome by the end of the month of May. The fluctuations in plant effluent quality (i.e., periodic high BOD_5 and TSS values) can be expected to continue as long as the problems with the short aerator basin detention time and inadequate plant staffing continue. The length of time and number of times the plant experiences these high BOD_5 and TSS values should be reduced due to the operational controls provided at the plant as a result of the assistance project.

Figure 4 shows the percent removal of BOD_5 through the entire plant (i.e., plant influent through chlorinated effluent) and through the final clarifier effluent (i.e., plant influent through final clarifier effluent). The total plant BOD_5 removal percentage was always greater than 90% after assistance. The difference in the BOD_5 removal percentages and BOD_5 concentrations in the chlorinated effluent from those shown for the final clarifier effluent may be attributed to reductions in the BOD_5 due to chlorination and possible chlorine interference with the BOD_5 test (chlorinated effluent samples are not dechlorinated). The differences between these results are not always consistent and can be expected to vary as the plant performance varies. It is felt that the most accurate measure of the activated sludge performance is provided by final clarifier effluent sample analysis. To accurately measure the activated sludge performance it is suggested that final clarifier effluent BOD_5 analysis be continued.

Results of the data analysis shown in this portion of the report indicate that a consistently high quality effluent was developed and maintained for approximately 2-1/2 months. However, the more important results are that the present plant operators were provided the means to recover from poor effluent quality in a minimum amount of time.

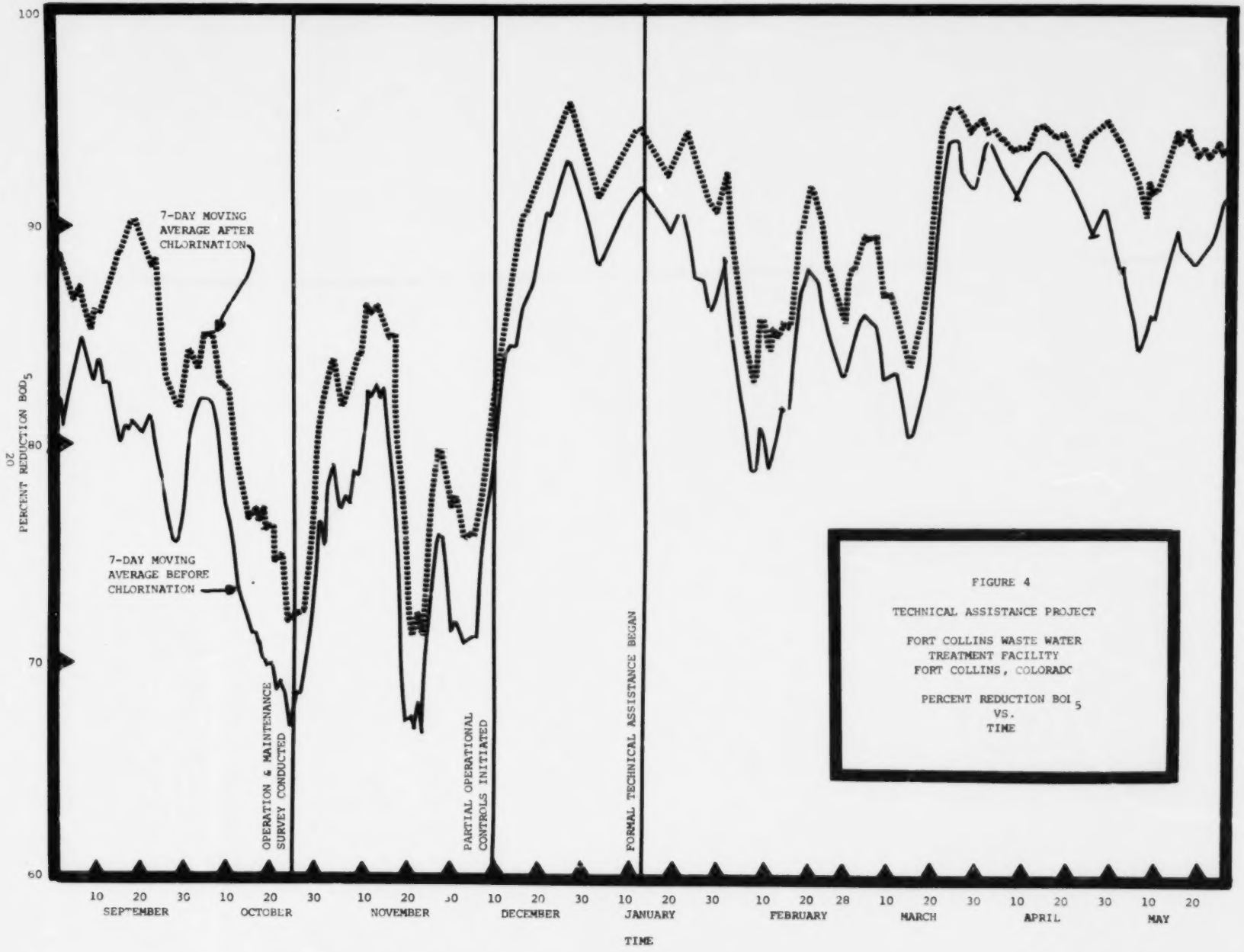

FIGURE 4

TECHNICAL ASSISTANCE PROJECT

FORT COLLINS WASTE WATER
TREATMENT FACILITY
FORT COLLINS, COLORADO

PERCENT REDUCTION BOD_5
VS.
TIME

IV. Summary and Conclusions

Data collected during an operation and maintenance survey of the Fort Collins Wastewater Treatment Plant #2 indicated that cycles of good quality effluent and poorer quality effluent were occurring. A technical assistance project was initiated by personnel from Region VIII of the U. S. Environmental Protection Agency on January 15, 1973, in an effort to produce a consistently high quality effluent from the Fort Collins facility.

A series of control tests and daily calculations were initiated at the Fort Collins facility to enable the operators to closely monitor the processes and to indicate when process controls needed to be changed. It is recommended that these control tests and calculations continue to be used to guide the operators in maintaining good operational control.

Initially, it was felt that the assistance project would be directed at "fine tuning" the facility. However, both physical and operational modifications were required to achieve desired results and flexibility.

The series of important physical modifications made to the Fort Collins facility are summarized below:

1. A modification was made to the location that the return sludge was introduced to the aeration basins (i.e., all return sludge was introduced at the head end of each basin).

2. The method of wasting excess activated sludge was changed to allow smaller amounts of sludge to be wasted over longer periods of time.

3. Leaky seals were discovered and replaced in the center well of the final clarifiers. Routine maintenance inspections and replacement of these seals is required in the future.

4. The adjustable effluent weirs on the aeration basin were placed into service to provide a means of flexible dissolved oxygen control. The seals adjacent to these weirs were observed to be leaking and replacement is recommended in the near future.

5. A wooden baffle was placed in the collection box at the end of the aeration basins to eliminate excessive turbulence and allow a more equal distribution of flow to the final clarifiers.

6. Modifications and adjustments were made to the return sludge ports in the final clarifiers to achieve removal of a uniformly thick return sludge.

Operational modifications were developed at the Fort Collins plant to minimize the time required to grow and maintain a good activated sludge. A large amount of sludge was initially wasted from the Fort Collins plant when the leaky seals in the final clarifiers were replaced. The poor settling sludge that developed after this solids loss and the problems encountered in trying to increase the sludge mass indicated that one of the main operational problems at the Fort Collins facility was developing and maintaining a mature good settling sludge. This fact was supported by prior difficulties that plant personnel had experienced in maintaining consistent control over the facility. A method to increase the sludge mass to a quantity that would encourage the development of a good settling sludge was achieved after several different attempts. The method involved using one of the aeration basins to "store" activated sludge solids while the other aerator was used to treat the incoming sewage and grow solids. After a desired mass of solids were obtained, they were dispersed throughout the system and held until a good sludge had a chance to develop. This method can be used in the future to rapidly develop a desired sludge.

Other operational modifications used during the project were to initiate "after hours" adjustment of process controls. Future operation of the facility should include greater than eight hour a day operation or effluent quality will, of necessity, be less than optimum. Twenty-four hours a day operation is recommended.

Other modifications that would improve plant performance at Fort Collins

could not be completed during the assistance project. These modifications are summarized below:

1. It is suggested that consideration be given to adding additional aeration capacity at the Fort Collins plant to provide a more easily controllable facility capable of producing a higher quality effluent.

2. The capability of operating one aeration basin as a reaeration tank and one basin as a contact tank (i.e., similar to the contact stabilization variation of the activated sludge process) should be provided at the Fort Collins facility.

3. Difficulty was encountered in adjusting and maintaining low return sludge flow rates. Consideration should be given to providing a smaller pump and metering equipment that would provide precise measurement and control at low return rates.

4. Inadequate flow control and measurement still exist on the waste sludge flow system despite modifications that were made. It is suggested that an independent wasting system be developed and variable flow control and metering be provided.

5. The capability of using one or both of the primary clarifiers as flow equalization basins would provide the operator with flexibility to maintain a higher solids mass in his system especially during summer months when infiltration occurs.

6. The capability to add polymers and chemicals to aid settling would allow the operators to minimize solids loss during periods of imbalance.

The primary objective of the assistance project at Fort Collins was to produce a consistently high quality plant effluent. As a result of the project the cycling effect was reduced substantially. Periodic effluent quality fluctuation can be expected, however, due to problems with the short aeration basin detention time and inadequate plant staffing.

Plant effluent BOD_5 concentrations had been reduced during the month prior to assistance to below 20 mg/l. However, effluent TSS concentrations were between 20 to 30 mg/l. A portion of the operational controls used during assistance had been initiated during this time. After assistance, the seven-day moving average values of BOD_5 and TSS concentrations in the plant effluent were below 20 mg/l. Apparently, changes in plant operation as a result of the assistance project provided conditions for better solids capture and lower TSS values. Seven-day moving averages of BOD_5 removal percentages for the plant were consistently greater than 90% after completion of the assistance project.

V. Recommendations

The following recommendations are made:

1. Control tests and calculations initiated during the assistance project should be continued.

2. The rubber seals in the center well of the final clarifiers and adjacent to the effluent weirs on the aeration basins should be inspected routinely and replaced when necessary.

3. The operational mode used during assistance to develop a good settling sludge should be used when required in the future to minimize periods of poor effluent quality.

4. Twenty-four hour a day operation should be provided at the treatment facility.

5. Additional aeration capacity should be considered.

6. Flexibility to operate in the "contact stabilization" mode should be provided.

7. Modifications to provide better return sludge flow control and measurement at low rates should be provided.

8. Modifications to provide better waste sludge flow control and measurement should be provided. Consideration should also be given to separa-

tion of the wasting and return sludge flow systems.

9. Flexibility to use the primary clarifiers as flow equalization basins should be provided.

10. Flexibility to add polymers and chemicals to the mixed liquor to aid settling should be provided.